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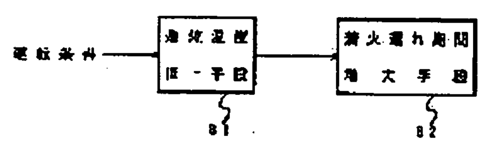
(54) DIESEL ENGINE CONTROL DEVICE

(57)Abstract:
PURPOSE: To reduce concentration of NOx and smoke in an operation zone in which oxygen concentration of intake gas becomes lower largely by setting an ignition delay period longer largely when combustion temperature is decreased by large decrease of the oxygen concentration of the intake gas by an EGR device or the like.

CONSTITUTION: A combustion temperature decreasing means 81 decreases combustion temperature in accordance with an engine operation condition. In this case, when an operation zone in which combustion temperature becomes low is reached, an ignition delay period increasing means 82 elongates an ignition delay period largely.



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CLAIMS

[Claim(s)]
[Claim 1] The control unit of the diesel power plant characterized by establishing a means to reduce an engine combustion temperature according to an engine service condition, and the means which lengthens an ignition-delay period sharply in the operation region where combustion temperature becomes low.
[Claim 2] Said combustion-temperature fall means is the control unit of the diesel power plant according to claim 1 characterized by being a means to reduce the oxygen density of inhalation of air.
[Claim 3] Said ignition-delay increase means is the control unit of the diesel power plant according to claim 1 characterized by being a means to delay fuel injection timing of a fuel until after a top dead center.
[Claim 4] It is the control unit of the diesel power plant according to claim 3 characterized by establishing a means to supercharge inhalation of air when delaying fuel injection timing of a fuel until after a top dead center.
[Claim 5] It is the control unit of the diesel power plant according to claim 3 characterized by establishing a means to strengthen a swirl when delaying fuel injection timing of a fuel until after a top dead center.
[Claim 6] Said oxygen density reduction means is the control unit of the diesel power plant according to claim 2 characterized by consisting of the deoxidation filter which removes oxygen from the inhalation of air which while branched to at least two and flows a branch pipe to them, a flow control valve which adjusts the inhalation-of-air flow rate to the branching path in which this filter is prepared, and a means to control this control valve according to a service condition.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the control unit of a diesel power plant.
[0002]
[Description of the Prior Art] In order to control generating of NOx which is an injurious ingredient in exhaust gas, the so-called EGR (Exhaust Gas Recirculation) equipment which carries out recycling of the inactive exhaust gas to an inlet pipe is common knowledge. With this EGR equipment, the EGR path (path for returning a part of exhaust gas to an inlet pipe) is equipped with the EGR valve, and the maximum temperature at the time of combustion is lowered by opening an EGR valve in the required field of EGR, and making inhalation air mix the exhaust gas (EGR gas) of a constant rate.
[0003] By the way, if an EGR rate (=(amount of EGR(s) / new air volume) x100) [%] becomes large, the discharge concentration of a smoke will increase. For this reason, the swirl is strengthened with JP,60-162018,A according to an EGR rate becoming large.
[0004] If an EGR rate becomes large, this will be strengthening a swirl and improving the air at the time of combustion, and mixing (mixture condition) of a fuel, and will say that a smoke will be reduced.
[0005]
[Problem(s) to be Solved by the Invention] However, it is difficult to suppress increase of the smoke when making an EGR rate high sharply with above equipment.
[0006] For example, if each concentration of NOx to an EGR rate and a smoke is shown in drawing 22 , with the increment in an EGR rate, it is contrary to NOx concentration decreasing greatly, and smoked concentration is large rapidly. In this case, if swirl-ratio SR is enlarged, smoked concentration can be generally made small, but if it still becomes the high field of an EGR rate, it is over the threshold value of smoked concentration. Since the reduction effectiveness of the smoked concentration by the swirl is acquired by speeding up the air at the time of diffusive burning, and the diffusion rate of a fuel, if an oxygen density becomes the bottom of a low situation according to a high EGR rate, the effectiveness is not so large more insufficient [the oxygen in air]. In addition, swirl-ratio SRs are SR=Vc/N, however a value defined by the Vc; swirl flow tangential direction rotational-speed N; engine speed.
[0007] Moreover, NOx concentration is also large if swirl-ratio SR is enlarged.
[0008] Then, this invention aims at reducing both NOx and a smoke in the operation region where combustion temperature becomes low by prolonging an ignition-delay period extremely, when the oxygen density of inhalation of air becomes low sharply with EGR equipment etc. and combustion temperature falls.
[0009]
[Means for Solving the Problem] The 1st invention established a means 81 to reduce an engine combustion temperature according to an engine service condition, and the means 82 which lengthens an ignition-delay period sharply in the operation region where combustion temperature becomes low, as shown in Fig. 1.
[0010] The 2nd invention is a means by which said combustion-temperature fall means 81 reduces the

oxygen density of inhalation of air.
[0011] The 3rd invention is a means by which said ignition-delay increase means 82 delays fuel injection timing of a fuel until after a top dead center.
[0012] In the 3rd invention, the 4th invention established a means to supercharge inhalation of air, when delaying fuel injection timing of a fuel until after a top dead center.
[0013] In the 3rd invention, the 5th invention established a means to strengthen a swirl, when delaying fuel injection timing of a fuel until after a top dead center.
[0014] The 6th invention consists of the deoxidation filter which removes oxygen from the inhalation of air to which while branched to at least two, and the oxygen density reduction means of the 2nd invention flows a branch pipe to them, a flow control valve which adjusts the inhalation-of-air flow rate to the branching path in which this filter is prepared, and a means to control this control valve according to a service condition.
[0015]
[Function] If combustion temperature becomes the operation region which becomes low, although NOx concentration decreases, smoked concentration will rise rapidly.
[0016] If an ignition-delay period is sharply lengthened by the 1st invention, both not only NOx concentration but smoked concentration will become small in this operation region. The usual diesel combustion takes place to the initial combustion to which the premixed air in which it is formed at an ignition-delay period blazes up at a stretch, and this combustion succeedingly, and is considered to be because for most combustion to turn into premixed air combustion and it to be hard coming to generate a smoke, if an ignition-delay period is lengthened sharply, although it consists of diffusive burning (the main combustion) in which that rate of combustion receives a limit by the diffusion rate of a fuel and air by this.
[0017] If the oxygen density of inhalation of air becomes low by the 2nd invention, combustion temperature will fall, and if fuel injection timing of a fuel is extremely delayed after a top dead center by the 3rd invention, an ignition-delay period will become long sharply.
[0018] By the way, in the 3rd invention, if fuel injection timing of a fuel is delayed until after a top dead center, although the oxygen density of inhalation of air decreases and both NOx concentration and smoked concentration can be reduced in the operation region where combustion temperature becomes low, since the absolute magnitude of oxygen runs short on the other hand, it is in the inclination for HC concentration to rise.
[0019] On the other hand, if inhalation of air is supercharged by the 4th invention, although an oxygen density decreases, since combustion is improved by securing the absolute magnitude of oxygen and strengthening a swirl with the 5th invention, HC concentration will be reduced sharply.
[0020] In the 2nd invention, if the oxygen density of inhalation of air is reduced with EGR equipment, an intake valve may carry out a stick with the carbon under exhaust air.
[0021] On the other hand, according to the 6th invention, since it is not necessary to flow back an exhaust gas during inhalation of air like EGR equipment, the stick of the intake valve by the carbon under exhaust air can be prevented, and the rise of the NOx concentration by the rise of the intake-air temperature by hot exhaust air is controlled.
[0022]
[Example] As for 21, in drawing 2 , an engine and 23 are [the EGR path where an inlet pipe and 25 open an exhaust pipe for free passage and 26 opens an exhaust pipe 25 and an inlet pipe 23 for free passage, and 27] the EGR valves of a diaphragm type following control negative pressure.
[0023] 28 is a negative pressure-limiting valve and adjusts the fixed negative pressure from the source of negative pressure to a three-stage according to the duty signal from a control unit 31. For example, when fixed negative pressure is introduced into the EGR valve 27 for the off-duty (OFF time amount rate of a fixed period) to the negative pressure regulator valve 28 as it is at maximum, 50% of an exhaust gas flows back. As for this, an EGR rate corresponds to 100%. If off-duty becomes small gradually, whenever [EGR valve-opening] will become small by reduction of the control negative pressure to the EGR valve 27, and an EGR flow rate will decrease. That is, whenever it makes off-duty small, an EGR

rate becomes small with 60% and 30%.
[0024] In this way, the EGR rate of the three-stage obtained is set up like drawing 3 to a service condition. In drawing, an EGR rate is 100% in a middle turn and an inside load region, and the full load region of low rotation. In these operation regions, it is because generating of a smoke is suppressed by about 0, so the stick of the intake valve caused by the inflow to the inlet pipe 23 of a smoke etc. is not generated even if it makes an EGR rate high. On the other hand, in high rotation and a heavy load region, since a combustion period is prolonged and generating of a smoke cannot be suppressed completely, an intake-air temperature rises by the rise of an exhaust-gas temperature, and increase of an EGR flow rate further, and the EGR rate is gradually decreased with 60% and 30% for the effectiveness of the NOx reduction by EGR decreasing etc.
[0025] In order to control an EGR rate according to an engine service condition, the control unit 31 which consists of a microcomputer is formed, and an EGR flow rate is gradually controlled by the control unit 31 based on the signal from the 32 air flow meter sensor 33 which detects accelerator opening (accelerator pedal opening), and the reference pulse and scale pulse mentioned later.
[0026] The map (not shown) which makes a parameter the accelerator opening (engine load considerable amount) Acc and an engine speed Ne is set up, the lookup of this map is carried out, and the target EGR rate at that time is searched for so that the property of the EGR rate (target EGR rate) shown in drawing 3 to the torque and the engine speed which an engine generates may be acquired. It is an EGR flow rate = air flow meter flow rate x target EGR rate about this and an air flow meter flow rate (new air volume) to an EGR flow rate. -- It calculates by ** and the off-duty to a negative pressure-limiting valve 28 is determined that the EGR gas of this flow rate will flow.
[0027] On the other hand, if the concrete structure of a fuel injection pump 20 is shown in drawing 4 , fuel injection timing of a fuel and the injection quantity of a fuel are the fuel injection pumps of the distribution mold by which electronics control is carried out, and this has them. [well-known]
[0028] In drawing 4 , the driving shaft with which 4 is connected with the output shaft of an engine 21, and 2 are the feed pumps of the vane mold driven with this driving shaft 4, and the fuel attracted by the feed pump 2 from the fuel inlet port which is not illustrated is supplied to the pump house 5 in housing 1, and is sent to the plunger room 12 of a plunger pump 3 through the intake path 6 which carries out opening to a pump house 5.
[0029] Pawl 9a of the face cam 9 fixed to the left end of a plunger 7 is connected with shaft orientations free [sliding], and while the face cam 9 and a plunger 7 are located on the same axis as a driving shaft 4 through this pawl 9a, about a plunger 7, it is constituted by shaft orientations possible [displacement] at the end (it is a right end in drawing) of a driving shaft 4.
[0030] The roller holder 10 which supports two or more rollers 11 is arranged at a driving shaft 4 and this alignment, and cam side 9b which makes the inequality rate cam of the number corresponding to the number of gas columns is formed in the face cam 9 at the connection section periphery of said driving shaft 4 and face cam 9, and the pressure welding of this cam side 9b is carried out to the roller 11 with the spring 15.
[0031] It is fed to an injection nozzle through the distribution port for each [the fuel attracted at the plunger room 12 from the intake slot 8 when the roller 11 arranged by the roller holder 10 while the intake slot 8 of an engine cylinder and the same number was formed at the tip at the plunger 7 and cam side 9b rotated in the driving shaft 4 was overcome and only the predetermined cam lift reciprocated leads to the plunger room 12 / which is not illustrated] gas column of every to a delivery valve.
[0032] 13 is the fuel return path which opens the plunger room 12 and the low-pressure pump house 5 for free passage, and the solenoid valve 14 of the high-speed corresponding movement mold driven according to an engine service condition with the signal (driving pulse) from a drive circuit is infixed in this fuel return path 13. It is prepared for fuel control, if a solenoid valve 14 is closed in the compression stroke of a plunger 7, injection of a fuel will be started, and if a solenoid valve 14 is opened, injection will end this solenoid valve 14. That is, according to the clausilium period, the injection quantity is controlled for the injection initiation stage of a fuel by the clausilium stage of a solenoid valve 14.
[0033] By the way, if an EGR rate is enlarged, although NOx concentration can be reduced, on the other

hand, smoked concentration rises rapidly. In this case, the smoked concentration in a high EGR rate is not insufficiently reduced only in case of the cure which raises mixing at the time of diffusive burning by strengthening a swirl.

[0034] In order to cope with this, if it becomes the operation region of a high EGR rate, by the control unit 31, fuel injection timing of a fuel will be delayed until after a top dead center so that an ignition-delay period may become extremely long. If it is made to contrast with the property (drawing 3) of an EGR rate and the property of fuel injection timing of a fuel is shown in drawing 5 R> 5, fuel injection timing will be carried out behind a top dead center (+4ATDC and +2ATDC) in the operation region applied to a heavy load from the inside load in a low rotation region. This is for controlling generating of a smoke by changing inhalation of air into a low-temperature condition more, and increasing the ratio of premixed air combustion by lengthy delay of fuel injection timing.

[0035] If it becomes an inside heavy load region in high rotation from a middle turn in drawing 5 , fuel injection timing is advanced with the increment in an engine speed. It advances fuel injection timing with the increment in a rotational frequency in order to keep an ignition stage almost constant in any rotational frequencies since whenever [ignition-delay crank angle] (value which converted ignition-delay time amount into whenever [crank angle]) becomes large in proportion to the increment in an engine speed even if this has the fixed time amount of an ignition delay. For example, although 1msec is equivalent to whenever [7.2-degree crank angle] by 1200rpm, when set to 3 times as many 3600rpm as this, 1msec is whenever [2.4-degree crank angle]. That is, in order to make an ignition stage the same by 1200rpm and 3600rpm, it is necessary to carry out about 5-degree tooth lead angle of the fuel injection timing from the time of 1200rpm at the rotational frequency of 3600rpm.

[0036] On the other hand, in the low load region which a smoke does not generate in drawing 5 , fuel injection timing is advanced from the heavy load region for controlling rapid increase of that it is not necessary to control smoked generating and and Hydrocarbon HC. this is because it originates in an ignition-delay period being prolonged, and delay combustion temperature falls [an ignition stage], so HC concentration is large on the contrary when a combustion chamber wall temperature makes it the same fuel injection timing as a heavy load region in the low load region which becomes low.

[0037] The timing (fuel-injection-timing considerable amount) which the solenoid valve 14 of drawing 4 opens is controlled by the control unit 31 so that fuel injection timing shown in drawing 5 is obtained.

[0038] Drawing 6 is a flow chart for controlling fuel injection timing and the fuel injection period (injection quantity) of a fuel, and is performed a fixed period.

[0039] First, engine-speed Ne, the accelerator opening Acc, the cooling water temperature TW, and a fuel temperature TF are read (step 1 of drawing 6). In addition, an engine speed Ne is calculated from a reference pulse (one pulse per rotation of a jet pump 20), and a scale pulse (36 pulses per rotation of a jet pump 20). Each sensors 34 and 35 have detected the cooling water temperature TW and a fuel temperature TF.

[0040] From the read engine speed Ne and the accelerator opening Acc, the lookup of each map of the basic fuel injection period Avm of the basic fuel injection timing Itm of a fuel and a fuel is carried out, respectively, and it asks for it (step 2 of drawing 6).

[0041] The map of the basic fuel injection timing Itm is a map (not shown) which set the accelerator opening Acc and an engine speed Ne as a parameter that the fuel-injection-timing property of drawing 5 is acquired. The basic fuel injection period Avm is made so long that the accelerator opening Acc becomes large like drawing 7 .

[0042] On the other hand, from a fuel temperature TF and the cooling water temperature TW, amount of fuel-injection-timing amendments deltaItm is calculated, and fuel injection timing is amended by adding this to the basic fuel injection timing Itm (steps 3 and 4 of drawing 6).

[0043] Amount of fuel-injection-timing amendments deltaItm is the sum of the two amounts delta Itm1 and delta Itm2 of amendments, drawing 8 is the property of amount of fuel temperature amendments deltaItm1, and drawing 9 is the property of amount of water temperature amendments deltaItm2. The amount of tooth-lead-angle amendments is enlarged because the rate of combustion becomes slow so that it becomes low temperature, so that it becomes low temperature also in which property. In other

words, temperature compensation is performed.
[0044] In this way, fuel injection timing IT (= Itm+delta Itm) and the basic fuel injection period Avm which were acquired are stored in the predetermined address (step 5 of drawing 6). The above-mentioned solenoid valve 14 is closed in this fuel injection timing IT, and a solenoid valve 14 is opened to the timing to which the basic fuel injection period Avm passed from that clausilium timing.
[0045] Here, an operation of this example is explained, referring to drawing 10 .
[0046] This drawing shows each concentration property of NOx and a smoke over the EGR rate at the time of carrying out fuel injection timing of a fuel behind the case where it carries out in front of a top dead center, and a top dead center, and by fuel injection timing in front of a top dead center (IT=-4ATDC), in connection with an EGR rate becoming high, although NOx concentration decreases, it is rising in the curve with rapid smoked concentration.
[0047] On the other hand, if fuel injection timing after a top dead center (IT=+4ATDC) comes, even smoked concentration shows the fall inclination. It is considered because an ignition-delay period becomes long sharply and the great portion of combustion is premixed air combustion with extreme delay of fuel injection timing, and the combination of a high EGR rate that smoked concentration decreases in this way so that it may understand, if the heat release pattern shown all over drawing is seen. That is, in having delayed fuel injection timing until after the top dead center in the conventional example which is not not much high, as shown in drawing 11 , the upward tendency of smoked concentration cannot be controlled, but in this example, since the great portion of combustion turns into premixed air combustion, smoked concentration can be reduced sharply also in the operation region of a high EGR rate.
[0048] Although the example whenever [after a top dead center / crank angle / whose] is 4 times shows to drawing 10 , since the critical point of premixed air combustion and diffusive burning changes with engine models, what times it is made behind a top dead center will set by matching for every engine.
[0049] Moreover, in order that a cooling loss may decrease sharply by the fall of combustion temperature on the other hand although whenever [isochore] gets worse by delay of fuel injection timing in this example if the property of specific fuel consumption is shown in drawing 12 , specific fuel consumption does not get worse just because it delays fuel injection timing. In addition, for whenever [isochore], work conversion efficiency is made to mean and work conversion efficiency is work conversion efficiency = illustration work / amount of heat release = illustration effectiveness/(1-cooling loss).
It is the thing of the value which is alike and is defined more.
[0050] Moreover, in this example, temperature compensation is performed by carrying out tooth-lead-angle amendment of the fuel injection timing, so that a fuel temperature and cooling water temperature become low, and the same ignition stage as the time of an elevated temperature is obtained by this also at the time of low temperature.
[0051] Drawing 13 is the 2nd example and, in addition to EGR equipment, this forms the supercharge equipment 41 which consists of a mechanical supercharger 42, an adjustable pulley 43, etc., and the equipment which controls a swirl ratio.
[0052] The supercharger 42 formed in the inhalation-of-air path 23 after unification of EGR gas is connected with the engine 21 through the belt 44 covered about over the pulley of a pulley 45 and 43 or 2 adjustable-speed pulleys fixed to an engine crankshaft, and if the adjustable-speed pulley 43 changes a pulley appearance through the actuator which is not illustrated with the signal from a control unit 51, the velocity ratio of an engine 21 and a supercharger 42 will become large, or it will become small.
[0053] This velocity ratio of both is controlled by the control unit 51, and 400 - 500mmHg and almost fixed charge pressure are maintained in all rotation regions. If charge pressure is raised by enlarging 3 to 1 and a velocity ratio and raising the rotational frequency of a supercharger 42, when an engine speed is low if the property of a velocity ratio is shown in drawing 14 and it becomes a high rotation region, since an EGR rate will become low, and HC concentration will also decrease and the maximum pressure in a cylinder will also go up, a velocity ratio is made small with 1 to 1, and it is made not to raise charge pressure.

[0054] Moreover, if the inhalation of air which the exhaust gas mixed flows into a supercharger 42, since a stick will be generated with the carbon under exhaust air etc., in order to prevent this, to a supercharger 42, the rigidity of a blade is high, and the thing of the screw type which touches casing by the line is used.
[0055] On the other hand, the swirl control unit of a rotation blade method The rotation blade 47 which is located near the spiral way 46b of the so-called helical type of suction port 46 (formed by abbreviation straight-line-like a [inhalation-of-air way 46] and spiral way 46b of the circumference of an inhalation-of-air valve stem), and is prepared free [rotation] like drawing 15 and drawing 16 , It consists of a link mechanism 49 made to connect with this blade 47, and an actuator 48 which drives this link mechanism 49, and adjustment of a swirl ratio is possible in the rotation location of a blade 47. For example, it becomes a high swirl ratio in the blade location of drawing 15 , and if a blade 47 comes to the location of drawing 16 , it will become a low swirl ratio. Early, the response of this rotation blade method is also wide range, and its swirl control is possible for it. Therefore, it is suitable for control of HC which reacts to a swirl ratio sensitively.
[0056] If the property of the swirl ratio to a service condition is shown in drawing 17 R> 7, the swirl ratio is made high, so that it becomes low rotation. In a high rotation region, since decline in the volumetric efficiency accompanying a high swirl ratio becomes open and the combustion improvement by high-pressure-izing of injection pressure weakens the need for a swirl, a swirl ratio is decreased so gradually that a rotational frequency becomes large.
[0057] In addition, although the actuator 48 for adjustable swirls is not illustrated, it consists of negative pressure-limiting valves which make control negative pressure to a three-stage by diluting atmospheric air from the source of negative pressure to fixed negative pressure to a diaphragm-type actuator with 2 stage spring, and this actuator.
[0058] In a control unit 51, the lookup of the map (not shown) of the swirl ratio (basic swirl ratio) assigned to the accelerator opening Acc is carried out to an engine speed Ne, it asks for a basic swirl ratio, the opening Vb of a negative pressure-limiting valve is read according to this swirl ratio, and this is stored in the predetermined address so that the swirl ratio shown in drawing 17 may be obtained (steps 11-14 of drawing 18).
[0059] HC to an EGR rate, a smoke, and each concentration property of NOx are shown in drawing 19 . Although the notation R shown in drawing, R+C, and R+C+S added supercharge and swirl control to what delayed fuel injection timing of R; fuel behind the top dead center (equivalent to a previous example), the thing which added supercharge to R+C;R, and R+C+S;R, they are things. However, the swirl ratio of charge pressure is the example of 5 in 400 - 500mmHg.
[0060] Although a previous example did not describe HC, combustion temperature becomes low with the combination of extreme delay of a high EGR rate and fuel injection timing, and on the other hand, they run short of the absolute magnitude of oxygen, and although both NOx concentration and smoked concentration can be reduced sharply, as R of drawing 19 showed, HC concentration is rising. In order to suppress the rise of this HC concentration, as shown in drawing 2 , it had to equip with the oxidation catalyst 40 currently conventionally used for the exhaust pipe 25 in the previous example.
[0061] On the other hand, in addition to NOx and smoked concentration, in this example, HC concentration can also be sharply reduced like drawing 19 in the operation region of a high EGR rate. That is, the oxidation catalyst 40 with which it was equipped in the previous example is not required of this example. Since combustion is improved by swirl strengthening in addition to the absolute magnitude of oxygen being secured by supercharge in a low rotation region, HC concentration can be sharply reduced even on the level which can clear a regulation value, without using an oxidation catalyst.
[0062] Drawing 20 is the 3rd example, and a deoxidation filter (called oxygen ******) is used for this example, and it is made to decrease the oxygen density under inhalation of air instead of decreasing the oxygen density under inhalation of air by introducing inactive EGR gas into an inlet pipe with EGR equipment.
[0063] In drawing 20 , the inhalation-of-air path 23 branches to two on the lower stream of a river of the

mechanical supercharger 42, and the deoxidation filter 63 is formed in one branching path 61. The deoxidation filter 63 has the well-known thing of structure which does not pass nitrogen using a hollow filament although oxygen is passed by the difference in the molecular size of nitrogen and oxygen. The oxygen removed with the filter 63 is thrown away into a flueway 25 through an interconnecting catwalk 64.

[0064] In order to adjust the inhalation-of-air flow rate which flows the near branching path 61 in which this filter 63 is formed, a flow control valve 65 is formed in a tee. When it consists of a butterfly valve which is not illustrated and a solenoid valve which adjusts the opening location of this butterfly valve to a three-stage according to the signal from a control unit 71 and a butterfly valve is in a closed position, whenever the whole quantity of inhalation of air is led to the branching path 51 and the opening of a flow control valve 65 of a butterfly valve increases, the inhalation-of-air flow rate led to the branching path 51 decreases. That is, if 100% of inhalation of air is passed to the branching path 51, the oxygen density of inhalation of air becomes 15%, and the oxygen density of inhalation of air increases gradually with 17% and 19% by making the inhalation-of-air flow rate which the branching path 52 is made to bypass increase (the oxygen density in atmospheric air is 21%).

[0065] In this way, the oxygen density of the three-stage obtained is set up like drawing 21 to a service condition. The gradual property of this oxygen density is equivalent to the gradual property (drawing 3) of an EGR rate. As for 15%, 17%, and 19% of each condition, an oxygen density corresponds to 100% of EGR rates, 60%, and 30%, respectively.

[0066] For this reason, the amount of the film of the deoxidation filter 63 is set up so that charge pressure can reduce an oxygen density to 15% under 400mmHg(s). In addition, it cannot be overemphasized that charge pressure fixed control is performed using a supercharger 42 so that the appliance inlet pressure of the deoxidation filter 63 may serve as 400mmHg(s).

[0067] According to this example, the deoxidation filter 63 and a flow control valve 65 work like the EGR equipment of the 2nd example. The difference from EGR equipment is not flowing back an exhaust gas during inhalation of air. For this reason, neither an intake valve nor a supercharger 42 can carry out a stick with the carbon under exhaust air, and the increment in NOx by the rise of the intake-air temperature by hot exhaust air can also be controlled.

[0068] It is possible to reduce the oxygen density of inhalation of air using EGR equipment or a deoxidation filter, in order to reduce combustion temperature, and also to make a compression ratio small or to cool inhalation of air beforehand etc.

[0069]

[Effect of the Invention] In the 1st invention, since a means to reduce an engine combustion temperature according to an engine service condition, and the means which lengthens an ignition-delay period sharply in the operation region where combustion temperature becomes low were established, NOx concentration can be reduced, without raising smoked concentration.

[0070] Since the 2nd invention is a means by which said combustion-temperature fall means reduces the oxygen density of inhalation of air, the same effectiveness as the 1st invention arises.

[0071] Since the 3rd invention is a means by which said ignition-delay increase means delays fuel injection timing of a fuel until after a top dead center, the same effectiveness as the 1st invention arises.

[0072] In the 3rd invention, since the 4th invention established a means to supercharge inhalation of air when delaying fuel injection timing of a fuel until after a top dead center, in addition to the 3rd effect of the invention, it can also reduce HC concentration sharply.

[0073] The 5th invention can reduce NOx concentration in the 3rd invention, without raising smoked concentration and HC concentration, since a means to strengthen a swirl was established when delaying fuel injection timing of a fuel until after a top dead center.

[0074] The 6th invention the oxygen density reduction means of the 2nd invention The deoxidation filter which removes oxygen from the inhalation of air which while branched to at least two and flows a branch pipe to them, Since it consists of a flow control valve which adjusts the inhalation-of-air flow rate to the branching path in which this filter is prepared, and a means to control this control valve according to a service condition, while being able to prevent the stick of the intake valve by the carbon

under exhaust air The rise of the NOx concentration by the rise of the intake-air temperature by hot exhaust air can be controlled.

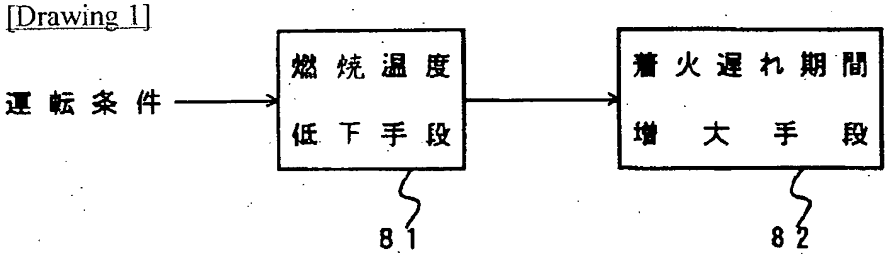
[Translation done.]

* NOTICES *

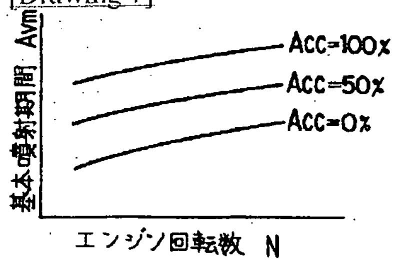
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

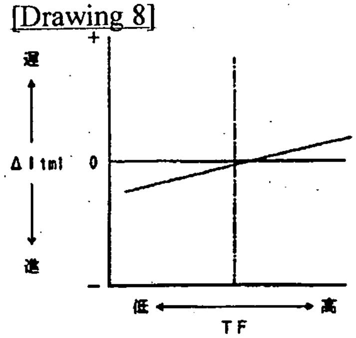
[Drawing 1]



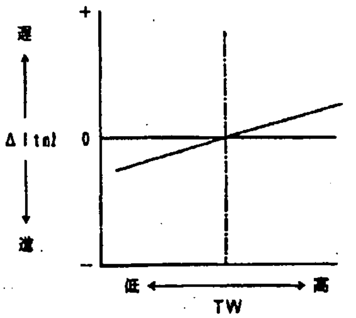
[Drawing 7]



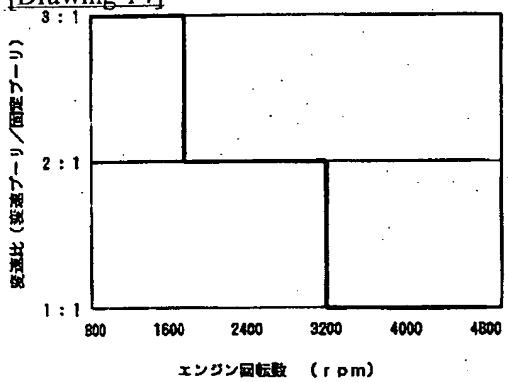
[Drawing 8]



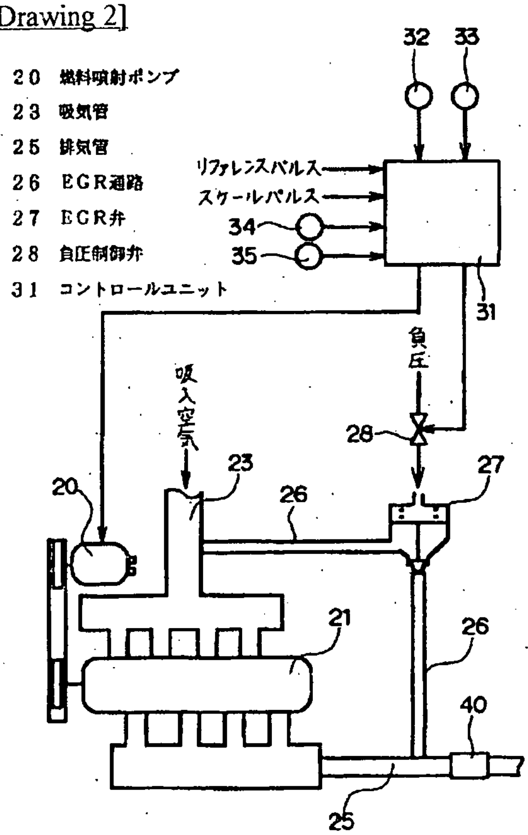
[Drawing 9]



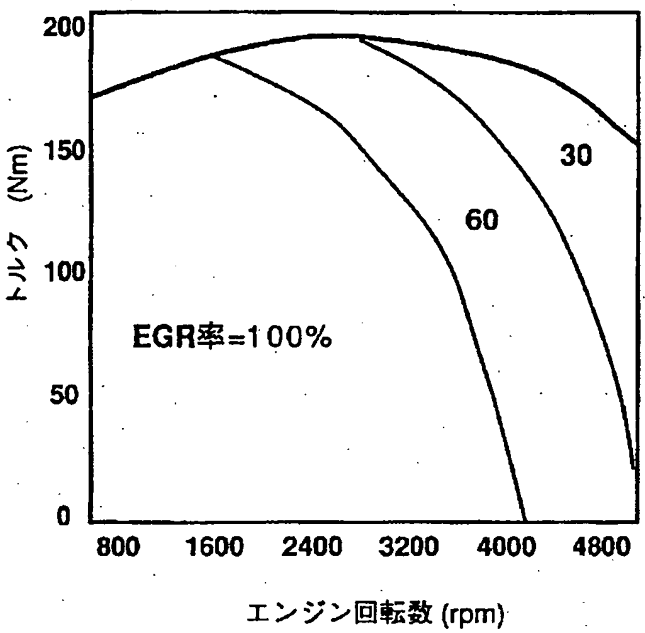
[Drawing 14]



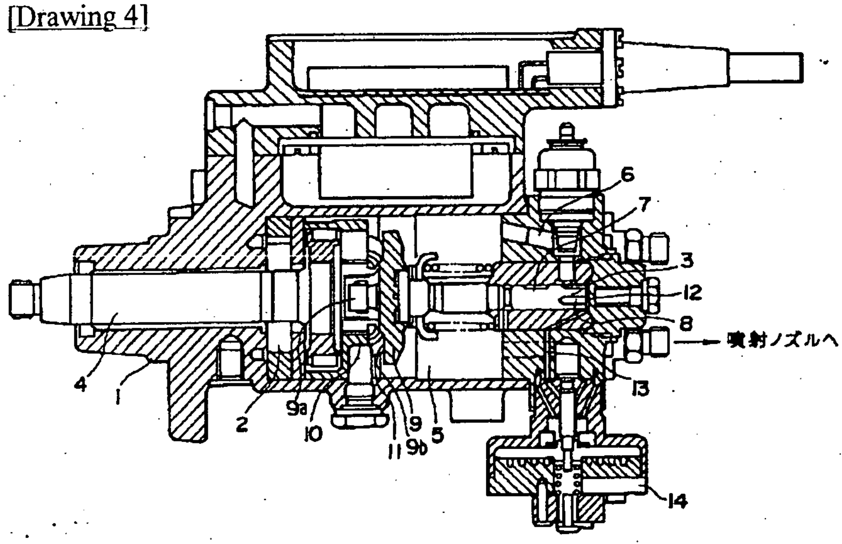
[Drawing 2]



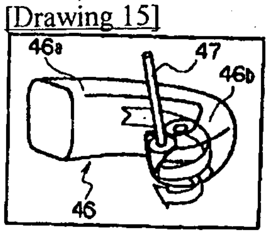
[Drawing 3]



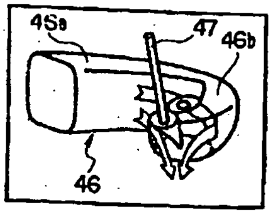
[Drawing 4]



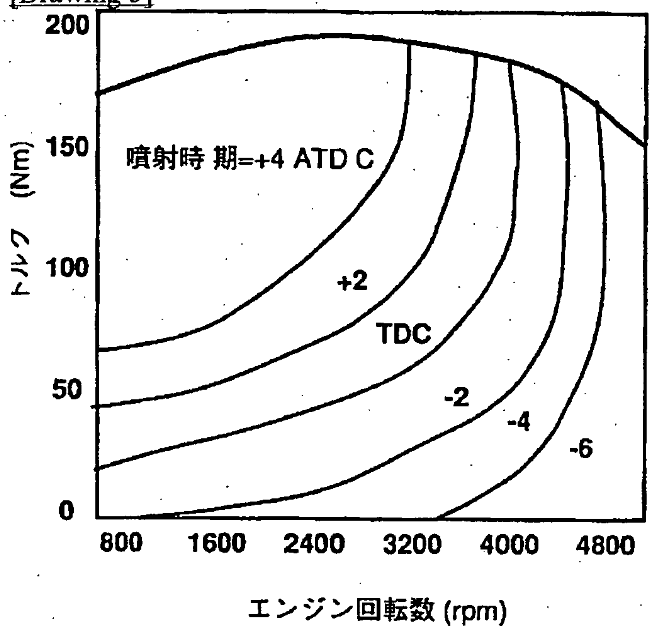
[Drawing 15]



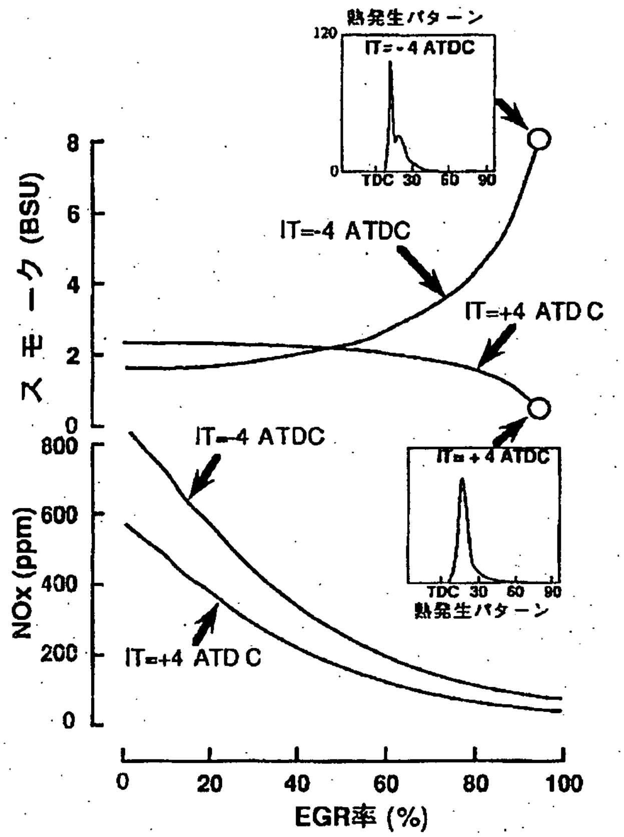
[Drawing 16]



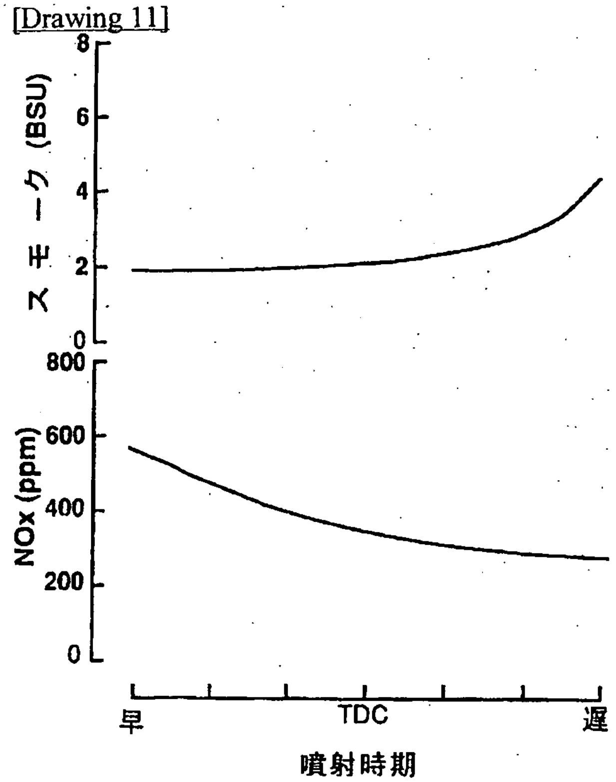
[Drawing 5]



[Drawing 10]

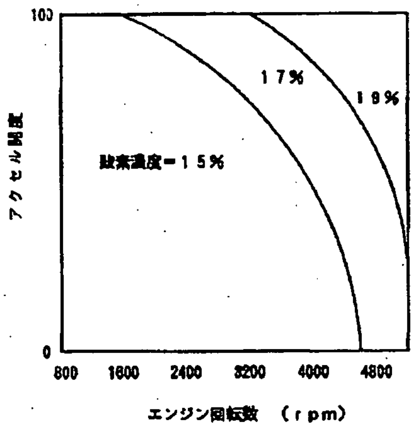


[Drawing 11]

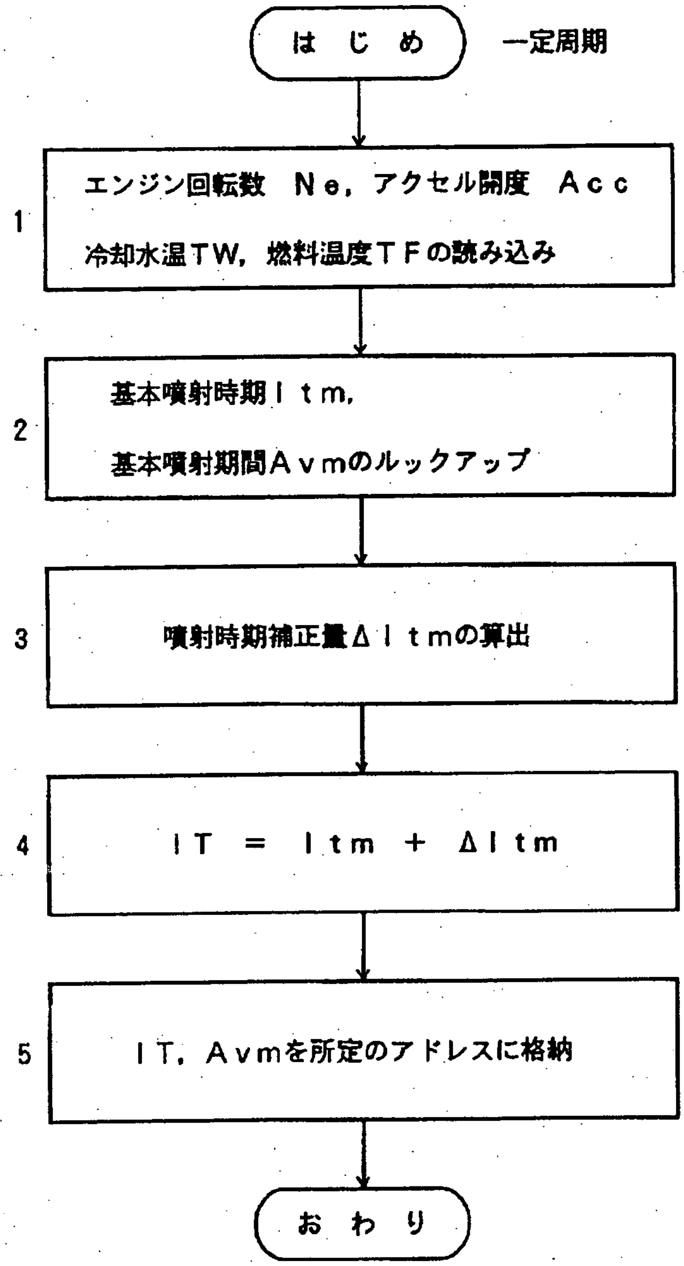


[Drawing 21]

f≤ ▼ ▼°△ ⊖ ù■ ■ L◆X°‡· ┴■ = ☺°▼n ☺▼■ ☻■<▼ °▼ L?L ‼αα n<▼≡△n▼ ■ L L?▌ ╠≥ ‼?·△ σ

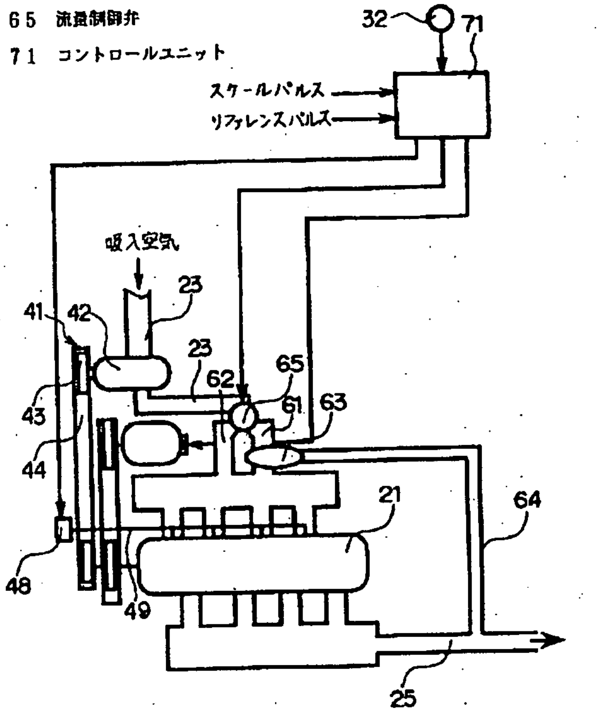


[Drawing 6]

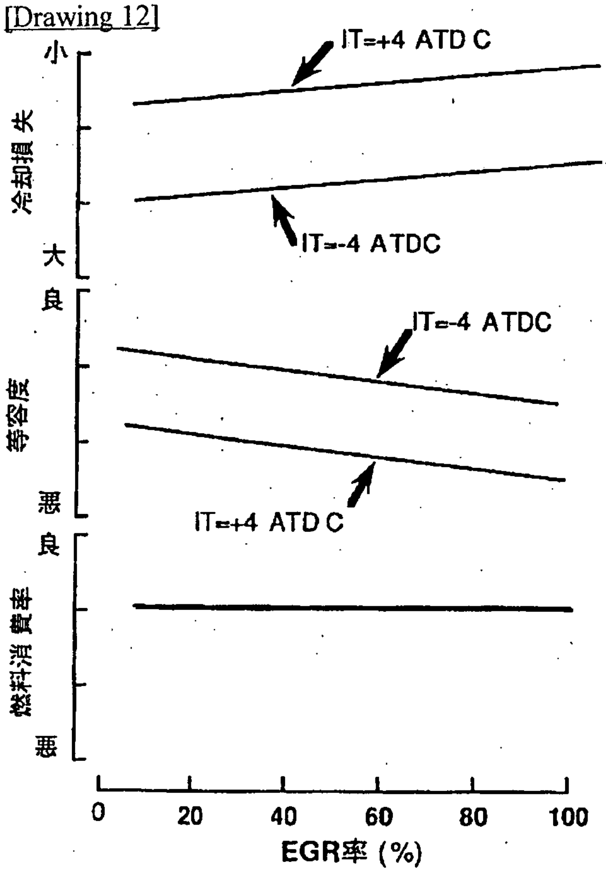

はじめ
一定周期
1
エンジン回転数 Ne，アクセル開度 Acc
冷却水温TW，燃料温度TFの読み込み
2
基本噴射時期Itm，
基本噴射期間Avmのルックアップ
3
噴射時期補正量ΔItmの算出
4
IT = Itm + ΔItm
5
IT，Avmを所定のアドレスに格納
おわり

[Drawing 20]

61, 62 分岐通路
63 酸素除去フィルター
65 流量制御弁
71 コントロールユニット

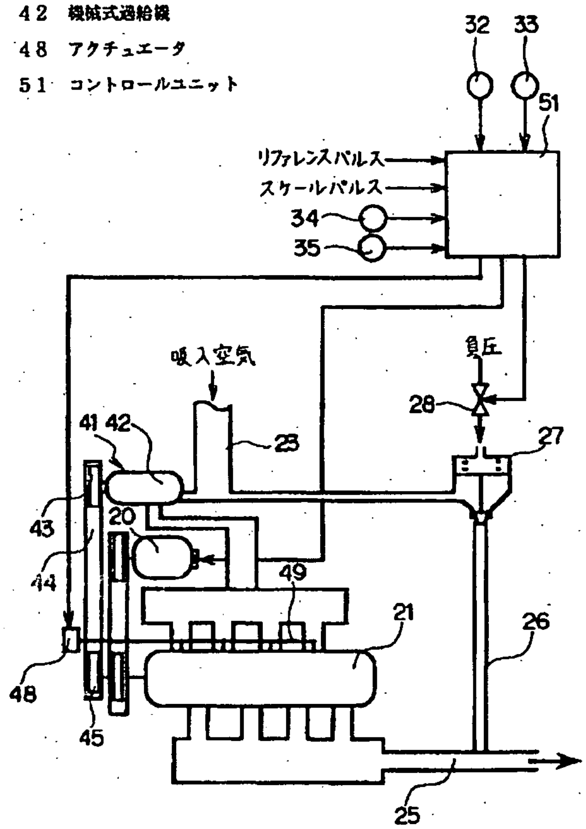


[Drawing 12]

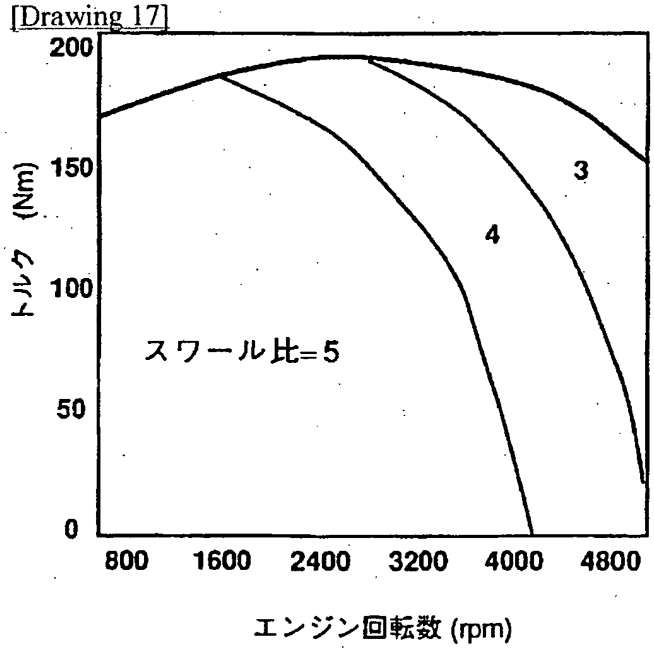


[Drawing 13]

41 過給装置
42 機械式過給機
48 アクチュエータ
51 コントロールユニット

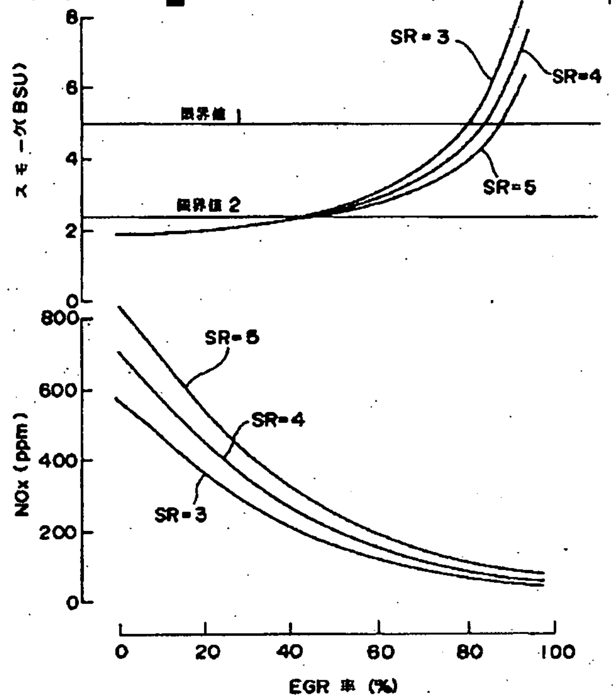


[Drawing 17]

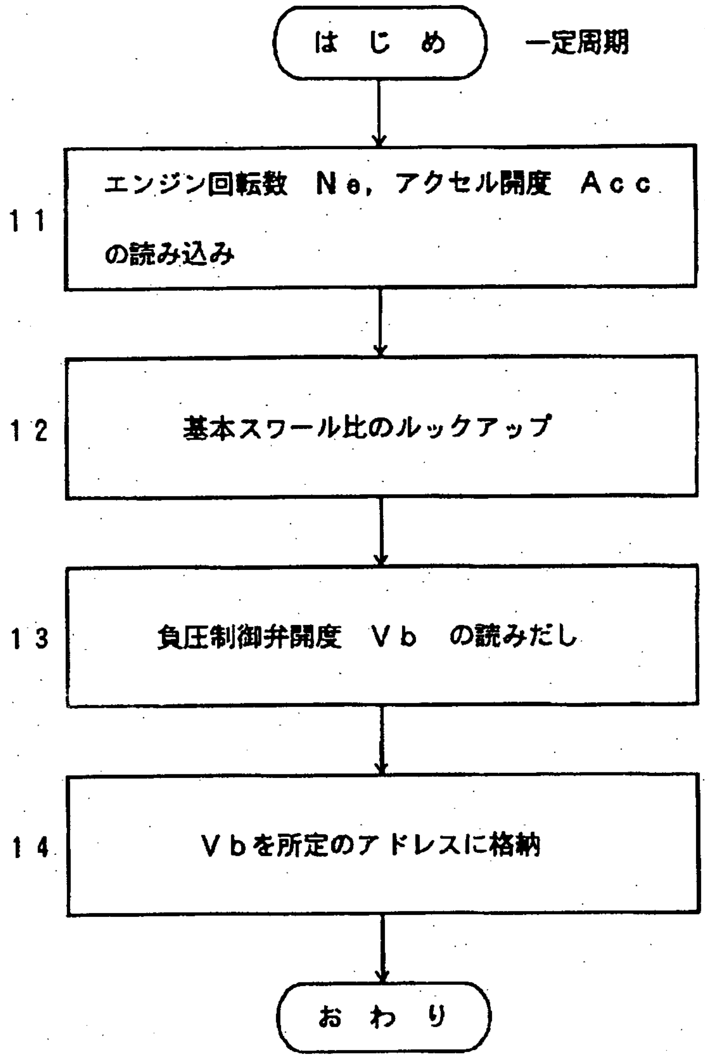


[Drawing 22]

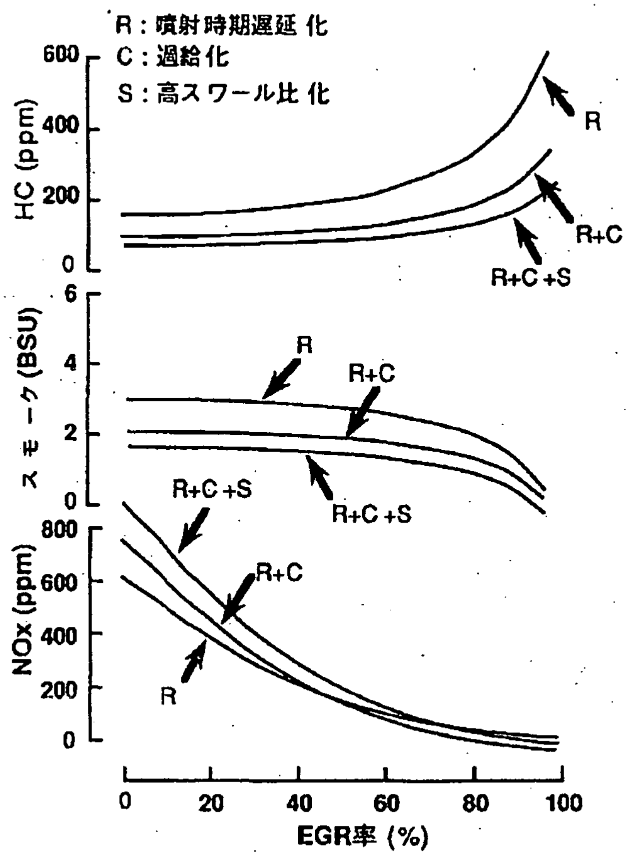
°|©≡`≡♠n?°7∞ ≡■ ü · ©ΣΔ√ ▸n9(α· °■n?·©├ ∩ Γ■ ü · ©ΓΔ√ ¶²0paß ç■▼°┐ αS├ n■≤ ─■ á≥



[Drawing 18]


はじめ
一定周期
11
エンジン回転数 Ne，アクセル開度 Acc の読み込み
12
基本スワール比のルックアップ
13
負圧制御弁開度 Vb の読みだし
14
Vbを所定のアドレスに格納
おわり

[Drawing 19]



[Translation done.]